Fermentation of Ensilage, by T. J. Burrill.

Modern Teaching Appliances in Biology, by R. R. Wright.

On a convenient method of subjecting living cells to Coloring Agents, by George L. Goodale. (Title).

The next meeting of the Association will be held at Indianapolis, and we are sure that it will give pleasure to the readers of the BULLETIN to learn that it will be under the presidency of Professor George Lincoln Goodale.

Botanical Notes.

The University of Pennsylvania has recently issued a large octavo volume entitled "Handbook of Information concerning the School of Biology," giving full accounts of the advantages offered by that institution for the study of the Natural Sciences. The claim is made "that Philadelphia is better suited for the pursuit of biological study than almost any other American city," and it would certainly appear from the volume before us that the faculty of this School of Biology will substantiate the statement.

Greeneria fuliginea in Italy. In a recent issue of the "Nuovo Giornale Botanico Italiano" (Vol. xx. 441), record is made of the occurrence of this fungus of the vine in Vittorio, northern Italy, where it is also stated that the parasite had hitherto been unknown except in the United States.

Memoirs of the Club. Vol. i, No. 2, of the Memoirs, containing Mr. Martindale's paper on "Marine Algæ of the New Jersey Coast and adjacent waters of Staten Island," is ready for distribution to members and subscribers.

Reviews of Foreign Literature.

Germination of Lichens on Moss Protonema.

In the "Revue Generalé de Botanique" for April, 1889, M. Gaston Bonnier gives a continuation of his researches on the synthesis of lichens and their germination on the protonema of mosses, the first portion of which was reviewed by Miss Gregory in the January BULLETIN. M. Bonnier adds no new species of mosses to those already enumerated, but illustrates his paper by a colored plate showing in fig. 1 the green protonema of *Dicra-*

nella varia overrun by the filaments of *Cladonia pyxidata* drawn from specimens gathered at Fontainebleau. Occasionally gonidia are mixed with these filaments, in which case the latter are bound to the ordinary thallus by a felt of hyphæ, but it also happens that a similar felt covers for a great length the ramifications of the protonema without the presence of gonidia. It would seem from these circumstances that the spores of lichens germinate without algæ, and are able to await for a long time the presence of this complement so indispensable to their organization by living as parasites on the protonemas of mosses.

These observations led to a series of cultures attempting to associate a fungus issuing from a spore of a lichen with the protonema of a moss. The cultures were made as pure as possible on sterilized sand kept moist by water previously boiled and protected from germs of the air. These cultures easily produced protonemas from the spores of the following mosses: *Hypnum cupressiforme*, *Barbula muralis*, *Funaria hygrometrica*, *Mnium hornum*, *Dicranella varia*, and *Phascum cuspidatum*. On these when well developed were sown the spores of lichens. This is preferable to sowing both spores at once, as ordinarily the lichens germinate more rapidly than the mosses.

In studying the germination of the spores of *Parmelia aipolia* on the protonema of *Hypnum cupressiforme*, a pure cell-culture on glass, the filaments of the lichen were seen to cover with a regular network the ramifications of the protonema, extending to the very tips of all the branches; a similar culture of the spores of *Parmelia aipolia* alone, under the same conditions, never having produced a development comparable to that on the protonema. In fig. 3 is represented another culture, that of *Barbula muralis* enclosed by a net-work of the filaments of *Parmelia physodes*, forming a closer envelope approaching the formation of a false tissue, analagous to that observed in certain lichens where the gonidia are formed by filamentous algæ, such as have been so well described and figured by M. Bornet.

In the case of *Mnium hornum*, which produces a protonema with very large filaments, a singular development occurred, the formation of propagules on the protonema of the moss in contact with the lichen filament. On the more slender branches of the

protonema, where the ramifications of the lichen were more dense, there were formed dilations clinging to the protonema, and here a curious phenomenon took place. The protonema swelled, forming a bud, in which accumulated a dense mass of protoplasm and threw across a partition, at the same time thickening its walls. Two or three months later, when all the rest of the cultures had disappeared, these "propagules" remained and later on germinated on a moist surface, producing the protonema of *Mnium* without the least trace of a lichen. This seems a remarkable mode of defence of the moss against the encroachments of the lichen filaments.

Never in all the cultures has the author seen fructification (apothecia, gonidia or other) on the filaments of the lichens, and ordinarily the cultures ended in the destruction of the protonema, on which the lichens seemed to act like a parasite. This partial asssociation, as in nature, seems to aid the lichen to germinate, permitting it to live during a time long enough to develop its filaments and search for the alga which would constitute its gonidia.

The development of these filaments was also observed on the leaves of mosses and hepatics, covering them with a false tissue; but the lichen does not develop definitely unless associated with algæ on the surface of the leaves of mosses. This was observed in the case of *Lecidea vernalis*, whose spores had germinated on the surface of a leaf of *Dicranella varia* which was found on the surface of a rock. After the filaments had developed and formed a net-work enclosing the leaf, their ramifications had encountered an alga and formed gonidia, constituting the ordinary association of the lichen, grafted, as it were, upon a moss.

Numerous such cases were observed on the leaves and stems of *Polytrichum*, *Dicranum*, *Mnium*, *Hypnums*, *Leskea*, *Jungermannia*, *Radula*, etc. It happens quite frequently at the base of rocks or beneath the stones along shady roads, as well as in the sub-alpine zone of the Alps and Pyrenees. Wherever mosses may be seen surrounded by various species of lichens, these may readily be observed germinating and following a similar evolution almost to the complete destruction of the mosses.

E. G. B.

Experiments with inverted Stems.

In the last number of the "Berichte der Deutsche botanische Gesellschaft," Professor Kny gives an account of some experiments he has recently made with inverted stems. *Hedera Helix* and *Ampelopsis quinquefolia* were chosen for this purpose. In 1884 several plants of both kinds were selected whose stems were about ten feet in length. These were so planted that both the stem and root end were completely under ground; the corresponding parts of the stem were bound, each to a separate support and allowed to grow in this manner for one year. At the end of this time the stem was carefully cut in the middle, or highest point, and from this time until 1889, both the inverted and the normally upright parts grew as separate individuals. The plants with inverted stems showed from the first a strong tendency to produce more and stronger buds near the real tip of the stem, that is, just above the ground, than at the other end. For the first year after the separation, only a few dwarfed buds were developed from the upper, while they developed and grew thriftily near the ground. The lowest of these were carefully removed each year, but the tendency to a richer production in that region than elsewhere along the stem remained somewhat active. The upper, that is, normally lower end of the stem also died down for some little distance shortly after the cut separating the two parts was made. But in the next following year or two, the uppermost side branches grew thriftily, and in the spring of 1888 the inverted plants presented in general the appearance of normally growing vines. The diameter of the stem at the ground was perceptibly greater than at the upper end. At the end of five years, or four if reckoned from the time of their independent existence, the inverted plants appeared to have accommodated themselves to their changed conditions. It was now thought time to examine whether this change was merely an outward one, or if it had reached deeper and affected the entire nature of the plant. A method previously followed by Vöchting was used to determine this. Sections of stems about twenty centimeters in length were cut from the inverted plants and hung in glass jars, some in the same position as when growing, others were inverted. The jars were kept in a dark

room and the plants exposed to a saturated atmosphere. At first normal stems from ordinary growing plants were tested in this way to see what would be the effect in the growth of tip and basal end. It was found difficult to make a sharp distinction by means of the outgrowth of adventitious roots and stems. However, another means of determining how far the nature of the growing substance remained true to its inherited tendency presented itself. This was the development of the so-called *callous* at the cut end of the stems. In every case of the stems taken from the normally upright growing plants, this callous developed much faster at the lower end of the stem than at the upper. This remained the same in whichever way the stem was placed. There was no possibility of deception as to the real upper end of the stem by examining this callous. Now this process was repeated with the inverted plants with exactly the same results. The organic upper end of the stem would be detected with perfect certainty by the difference in the formation of the callous.

The author makes no attempt to explain this phenomenon. It was found to be a characteristic of the plant in its normal condition, and the experiments tried on the inverted stems proved that in this case at least, the inner nature of the plant had not undergone an entire change. Externally a complete change had taken place so far as morphological characteristics were concerned. E. L. G.

ZURICH, SWITZERLAND, July 28.

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Agarics—North American. Robt. K. Macadam. (Journ. Mycol. v. 58-64, Part I).

Albinism among Flowers. C. R. Orcutt. (West Am. Sci. vi. 77). A list of albino plants collected by the author in California.

Algæ of Minnesota—Some. J. C. Arthur. (Reprinted from Bull. Minn. Acad. Nat. Sci. iii. 97-103).

American Magnolias. (Garden, xxxvi, 28).

Anemone cylindrica with Involucels. H. J. Webber. (Amer. Nat. xxiii. 264).

Found at Lincoln, Nebraska.

Aster—A Key to the Species of. Alfred C. Stokes. (Journ. Trenton Soc. Nat. Hist. ii. 52-74).